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Development of a Rolling Process Design Tool for Use in Improving Hot Roll Slab Recovery

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U.S. Department of Energy

Lawrence
Livermore
National
Laboratory

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Development of a Rolling Process Design Tool for Use in Improving Hot Roll Slab Recovery

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Quarterly Report: Q4 FY01

LLNL Input

A model of the 28-inch, laboratory mill at Alcoa Technical Center was constructed, and a preliminary calculation run using an estimated initial ingot size and pass schedule to assess the computational requirements for the simulations and to develop a procedure for adjusting the mill configuration and model boundary conditions between passes. The simulation was run through three passes, and the mechanical and contact thermal boundary conditions appear to be working appropriately. The figure shown below is a contour plot of the thermal field after three passes.

A summer student at LLNL studied the effects of the spatial discretization on the accuracy of the thermal contact solution. The results of this work provide a guide for selecting the proper element size to give a desired level of accuracy for the thermal solution. The mesh in the figure below is too coarse to guarantee that the transient temperature field is accurate to within 10 degrees. Additional mesh refinement is needed. In anticipation of this, it was confirmed that this calculation would run effectively in parallel on the Compaq cluster at LLNL.

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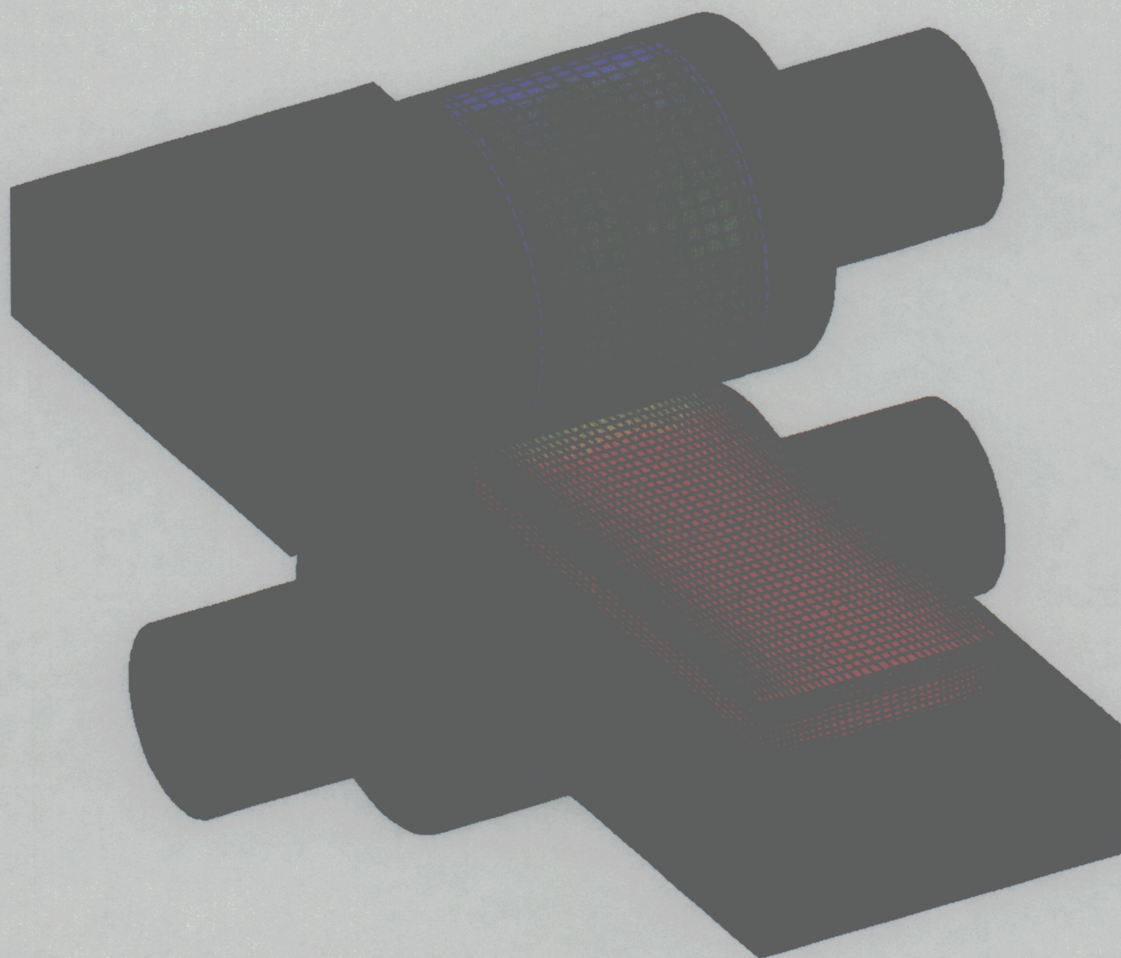

The actual ingot geometry and pass schedule were received from Alcoa late in the quarter and the geometry has been modified to account for the correct ingot size. Some aspects of the thermal treatment need further development. These include accounting for the inter-pass delay on heat conduction within the roll and incorporating film coefficient boundary conditions consistent with natural convection to the air and the coolant/lubricant sprayed on the roll. Appropriate film coefficients will be obtained from Alcoa.

Alcoa Input

- Determine material constitutive properties (Alcoa proprietary data):

The constitutive property of an aluminum alloy from 5xxx series has been obtained by using the hot tensile testing fixture conducted at the Deformation Simulator at Alcoa Technical Center.

The constitutive equation of this alloy was formatted in a hyperbolic sine type equation in terms of temperature, strain rate, and flow stress. Four material constants were determined.

- Characterize hot rolling process: boundary and initial conditions (protected CRADA information)

The boundary and initial conditions of hot rolling process were quantified from experiments conducted at the 28" hot mill at Alcoa Technical Center. These conditions would include roll geometry, roll speed, initial roll temperature, slab geometry, and initial slab temperature. A rolling schedule of the alloy mentioned above was established for rolling experiments and for numerical simulation purpose.

Note:

1. Alcoa proprietary data means the data was developed by Alcoa before this CRADA activity started
2. Protected CRADA information means Alcoa data was produced in performance of this CRADA project. This data can not be released for 5 years
3. All data generated by LLNL under this CRADA project is restricted under the rules governed by "Protected CRADA Data"

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U.S. DEPARTMENT OF ENERGY
FEDERAL ASSISTANCE PROGRAM/PROJECT STATUS REPORT

1. Program/Project Identification No.	**2. Program/Project Title** **Development of a Rolling Process Design Tool for Use in Improving Hot Roll Slab Recovery**	3. Reporting Period 07/01/01 through 09/30/01
4. Name and Address PI: Richard Couch; Lawrence Livermore National Laboratory; L-99; P.O. Box 808; Livermore, CA 94550		5. Program/Project Start Date 06/01/01 6. Completion Date 05/31/04

7. Approach Changes

[x] None

8. Performance Variances, Accomplishments, or Problems

[x] None

9. Open Items

[x] None

10. Status Assessment and Forecast

[x] No Deviation from Plan is Expected

11. Description of Attachments

[x] None

12. Signature of Recipient and Date	13. Signature of U.S. Department of Energy (DOE) Reviewing Representative and Date

U.S. Department of Energy
Milestone Log

Development of a Rolling Process Design Tool for Use in Improving Hot Roll Slab Recovery

Identification Number	Description	Planned Completion Date	Actual Completion Date
1.	Constitutive model defined: PQ3	3/02	
2.	Fracture model defined: PQ5	9/02	
3.	Friction model defined: PQ3	3/02	
4.	Finite element model constructed: PQ4	6/02	
5.	Rolling data produced: PQ6	12/02	
6.	Initial code validation studies completed: PQ8	6/03	
7.	Validate models in a production configuration: PQ10	12/03	
8.	Complete parameter study: PQ12	6/04	